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# the Bed Cultivation of Cereals

AN INTENSIVE METHOD FOR  
THE GROWING OF CEREALS

BY

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# The Bed Cultivation of Cereals.

## AN INTENSIVE METHOD FOR THE GROWING OF CEREALS.

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### I.

In spite of the technical sound of its title, the question dealt with in this article is one which can and must be made easily intelligible to the ordinary lay mind. It involves nothing less than the to be or not to be of Palestinian corn growing, and the possibility of colonising large tracts of the country.

The prevailing opinion in Jewish circles in and out of Palestine is that corn growing will never be made to pay in Palestine except after a number of years, and even then only to a small extent. This lesson is derived from the experience of the Palestine corn-growing colonies themselves. The colonists, as a matter of fact, are making very slow progress. The opinion of the unprofitable nature of corn growing in Palestine has become so deep-rooted that in forming projects for our future colonising activity we calculate on harvests of a poorness such as is found in few lands, even with extensive cultivation of the soil, *i.e.*, on 600 kilogrammes of wheat to the hectare. I have, in another place,\* made a comparison of the wheat yields obtained in various lands, which shows that nearly all countries return higher yields than the Palestine of the present, or than the Palestine of the near future will do, according to the view of some judges. If the first half of this statement is unfortunately true, the second half need not necessarily be so.

### II.

Let us see what results are obtained in countries with intensive culture on small areas. We may take China as representing the ideal at which we shall have to aim for many years to come. In his "La Cité Chinoise" (Paris, 1885), Eugène Simon gives the yield by weight of the products of an average Chinese farm.

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\* Small holding and Irrigation, p. 18.



These were: Kg. 9,910 rice, Kg. 2,100 wheat, Kg. 1,604 tea, Kg. 300 large beans, Kg. 160 maize, Kg. 291 oil (probably sesame oil), Kg. 180 buck-wheat, Kg. 230 sugar, Kg. 180 tobacco, Kg. 5,000 yams, Kg. 9,600 mangel wurzel, Kg. 15,000 cabbage, 80 pieces of cotton cloth, Kg. 9,720 clover, Kg. 1,095 oil cake, Kg. 16,200 straw of various kinds, besides vegetables and fruit. All this was produced on a plot of 1.94 hectares. The farmyard produced, in addition, 12 young pigs, 4 kids, 150 chickens and ducklings, and 3,500 eggs. These yields, it is true, are due in the first instance to artificial irrigation, which renders possible a number of harvests in one year. With the exception of a third of a hectare, the whole area was irrigated. Not less important is the second factor—that of human labour; in the field, besides the owner and his two sons, there were three hired labourers at work, and in the farmyard a maid, besides his women folk. Nevertheless, the result remains astonishing. The cash receipts did not merely suffice for the full maintenance of fourteen persons, but left the owner a clear profit of about fr. 4,000, after deducting amortisation for the small stock of implements and cattle required for this kind of cultivation and for the household appointments.

There are districts in China where agriculture is carried on without irrigation, *e.g.*, in many portions of Manchuria. Here wheat, sorgho, and sesame are cultivated by means of replanting and hilling on beds. "The harvest thus acquired is so rich that the corn gathered in from a tiny plot of ground not only suffices fully for the needs of the numerous family of the *mansa* (peasant) but leaves a surplus. Harvest failures are almost unknown in Manchuria." So quotes Demtschinsky from a journal in which bed cultivation (*Ackerbeetkultur*) in Manchuria is described.

### III.

Demtschinsky is the chief champion of this method of cultivation in Europe. Without sharing his optimism on its future—"not five years will pass," he says, at the end of "*Ackerbeetkultur*," which appeared in 1911, "before the principles of bed cultivation will be applied even to the smallest farms" (and just these)—we must still say that we have here a question of great practical importance.

"Bed cultivation for corn products has been practised for more than 3,000 years over the whole of the huge extent of the Chinese Empire. It is based upon the imperial edict of 1762 B.C.,

and since that time the whole of China, with its population of 400,000,000, owes its existence exclusively to this method, which continually increases the productivity of its fields." (Demtschinsky, preface to "Die Ackerbeetkultur.") We, see therefore, that this method is extremely widespread in China, though strange to say in Europe it has been entirely neglected. I shall, therefore, briefly describe its nature.

Without going deeply into the physiology of plants, I must in a few words indicate the biological processes which precede the growth of plants, so far as they influence the harvest produce. Human labour in agriculture is directed towards the loosening of the upper layer of earth, enriching it with manure, and keeping away harmful influences. These activities, which are in use all over Europe, have for their object first of all to provide good nourishment to the parts of the plant above the ground, and assist in their development. They do this by providing the consuming organs of the plant—the roots—with the requisite nutriment in the most acceptable form. The result is that our cultivated plants always have somewhat weak and flat roots, as they find their requisite nutriment in the upper layer of the soil, which has been well loosened, exposed to the influence of the air, and heavily manured. The Chinese method proceeds on another principle. It seeks to strengthen the roots of the plants, and leads them down to the deeper layers. This is accomplished partly through the replanting of the individual plants, and partly through their hilling. It is obvious that plants with deep-striking roots are independent of unfavourable weather conditions, especially of drought, as the deeper layers of the soil are always more moist than the upper ones, while at the same time they are provided with a larger supply of nutriment, as the extent of soil on which they draw is much larger. A plant with strong deep-striking roots develops its open-air portions correspondingly. The stronger plants produced in this way require more space to themselves; they cannot be so close to one another as plants with smaller roots, and correspondingly weaker development of their open-air portions.

#### IV.

Bed cultivation then effects, through replanting and hilling, a deepening of the roots and a greater multiplication of the plants, *i.e.*, the formation from one grain of several stalks, of which each bears an ear. This method, it need hardly be explained, requires

a far greater expenditure of labour than that which is usual in Europe and in countries with still more extensive cultivation. It is quite impracticable in the case of large areas. In other words: bed cultivation is the greatest enemy of large estates. Herein lies the explanation of its extensive use in China and its rejection in the west. China is the country of small holdings. There are in this huge empire provinces as large as France and Germany, with five to seven inhabitants to the hectare, *i.e.*, 500–700 to the square kilometre, and districts of the size of Belgium, with 12–15 persons to the hectare, = 1,200–1,500 inhabitants to the square kilometre. “No country in Europe, with the exception of perhaps the Isle of Jersey, and the Spanish province of Valencia, can in this respect compare with China,” says E. Simon, in “*La Famille Chinoise*.” This density of population is so extraordinary that it has often been disputed, and the Chinese statistics called into question. Simon, who traversed the Chinese Empire in various directions, confirms from personal observation the, to us, almost incredible agglomeration of human beings everywhere in this empire, from the sea coast in the east to the borders of Tibet in the west. “From one end of China to the other villages, tiny settlements, and single houses defiled before us, so to speak, in such close succession, as we see only in the immediate neighbourhood of our large cities. The land encroaches on the water. Fields and gardens borne on rafts cover large lakes. Rocks bear harvests.” So Simon describes the results of the density of population in this country. Nor must it be thought that there is fierce competition for a living. Thanks to the industry of the population, and the methods of agriculture used, the earth yields rich harvests without the soil being exhausted.

If the total area of China is divided by the number of households, it is found that the average amount of ground owned by each family is three and a half hectares. There are certainly a large number of families which possess only from one and a half down to half a hectare. Only a few possess 20 hectares; the number of estates of 100 hectares is exceedingly small, and there are hardly any larger than 100 hectares. In each of the large provinces with thirty to forty million inhabitants one could find three or four estates of 300–500 hectares. The area cultivated by an owner never exceeds twelve hectares. The result of this division of estates is that in China there is practically no man who does not call a piece of ground his own. One portion of the property, say

three-quarters of a hectare per family, is inalienable. Hence all interests are centred in the cultivation of the soil. Thanks to the wise regulations of Chinese emperors of hoary antiquity, and of the not so distant past, it was found possible to retain every increase of population for the country by internal colonisation. The ownership of the soil did not remain here the privilege of a favoured caste of conquerors,\* but everyone could acquire a plot which he could cultivate in peaceful labour along with his dependants.

## V.

How entirely different are the conditions of ownership in the civilised West! The soil is in the hands of a few large proprietors, whose estates in many places are veritable latifundia. It would carry me too far afield were I to go here into the reasons for this development. I will merely give a few figures to show how absurdly property is divided in the West. In 1873, 874 persons owned not less than  $28\frac{1}{3}$  per cent. of the whole area of England and Wales, while in Scotland 580 persons owned  $79\frac{1}{2}$ %. Half of Great Britain belongs to a couple of thousand people. Similar are the conditions in Ireland, where 744 persons own 47.7% of the soil. Great Britain has introduced the same policy into its colonies. In Australia 68%, and in New Zealand 72.5%, of all property owned is in the hands of large proprietors, the estates ranging from 1,000 to over 50,000 acres. In the United States the average size of the farms is 146 acres, and only 17.5% of the total area is in estates of under 100 acres. More than half is covered by farms of 100–500 acres, and not less than 23.8% of the total area is taken up by estates of over 1,000 acres. In France 71% of the total area is in the hands of owners with estates of 10 hectares—25 acres and over. In Germany the larger half of the cultivated area (51.5%) consists of estates of 20–100 hectares and over.

In almost all countries of the West we meet with large estates, or, at any rate, with estates of medium size. This fact is of the utmost importance for the problem which we are considering. A comparison of the conditions of land ownership in China and in the West leads to the conclusion that the method of cultivation

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\* China also has lived through its feudal period with all the accompanying evils. But as early as the eleventh century large estates were abolished by a thorough-going agrarian reform. All estates exceeding 1,000 Mon.—6 hectares had to be ceded to the State, and the Crown lands and other property falling to the Government could no longer be sold but only leased.



and the direction which it takes varies strictly with the system of ownership.

## VI.

China with its small holdings was able to adopt the most intensive methods of agriculture, that of gardening and of bed cultivation, while Europe and America had to "intensify" their agriculture in a different manner. The Chinese method is practicable only where the plot of ground can be cultivated by the owner with the help of his dependants alone, or where a number of labourers can be rapidly procured whenever needed. It has to be given up as soon as the farmer disposes of a large area and labourers are hard to get. The conditions of ownership in the West determined for modern agronomy, for the science of agriculture, the direction of its investigations. The idea of "intensity" was conceived by the theoretical and practical agriculturists in Europe and America quite differently from what it was in China. The size of the estate in the West forced the scientist to do violence to the nature of the cereal and to change the plant from one with a deep root into one with a flat root. He had to discover methods which would render possible the successful cultivation of large areas. Hence the emphasis laid upon proper manuring, and upon the use of agricultural machinery. By means of chemical fertilisers large tracts of land could be made productive, while by means of improved implements and machines the surface soil could be loosened and prepared for the reception of the seed, and the harvest could be gathered in rapidly and cheaply. This is unquestionably "intensive" cultivation according to the ideas of the Westerner. But it is extensive in comparison with that of the Chinaman, who grows his corn by the methods of gardening.

## VII.

Western agricultural science attacked the champion of Chinese bed cultivation in Europe, the Russian Demtchinsky, with arguments which will not hold water. First it was said that the method could not possibly be applied in practice. Certainly it is impracticable so long as the owner claims as his own an area of, *e.g.*, 10 hectares, which he wishes to cultivate in its entirety. If, however, he could bring himself to plant only a quarter of his estate with corn, expending on it the same amount of labour and manure, though economising in seed, he would obtain the same yield from the small plot as from the large one. He would effect a saving



not only in land but also in implements, draught cattle, and buildings. The Chinaman whom I cited from Simon at the beginning of this article required for the cultivation of his 1.94 hectares only one buffalo, and even this animal he did not occupy completely on his own farm ; he was able to hire it out for not less than 140 days. Our agricultural science, however, represents only to a very small degree the interests of farmers owning estates of 10 hectares. As we have seen, the larger portion of the cultivable soil in the West is in the hands of large owners. For these the replanting of corn is out of question. Only the hilling can be at all considered. Demtschinsky's propaganda gave an impulse to the investigation of serviceable methods of hilling for large fields, to the construction of suitable implements, etc.

### VIII.

A further objection brought against replanting was that it caused an excessive "multiplying" of the plants, involving the danger of an irregular ripening of the ears. On this account, it was said, modern agriculture aimed at the production of such kinds of corn as are capable of producing only a moderate number of stalks from one grain. This view is contradicted by numerous experiments which have been made with a view of diminishing the quantity of seed per hectare as much as possible, and, at the same time, obtaining the maximum harvest. It is known that single grains planted at wide intervals produce a greater number of stalks with ears ripening evenly than grains sown close together. As far back as the first international exhibition in London in 1851, Major Hallet exhibited "pedigree" wheat which he had obtained by careful selection and by planting at wide intervals. Every grain had sufficient room to produce 15, 20, 25 and even 90-100 ears by multiplying the stalks. A barley plant exhibited by him later had 110 stalks with 5-6,000 grains. The Hallet wheat seed, so renowned at one period, could only yield satisfactory results in places where, under suitable conditions of soil, it was planted at wide intervals. The French scientists, M. Grandeau and F. Desprez, have also obtained very rich harvests through planting at wide intervals. Desprez's experiments made on a plot of a quarter of an acre yielded at the rate of 83-90 bushels per acre. Grandeau wrote as follows on the results of his experiments: "In suitable soil one grain of wheat can yield 50 stalks (and ears) and over, spreading in a circle of 13 inches diameter." Kropotkin reckons

that the bread required for the whole year by one man, *i.e.*,  $8\frac{1}{2}$  bushels of wheat, can be supplied from one-twentieth of an acre. This would correspond to a yield per hectare of Kg. 11,500. These figures, arrived at by calculating from the yield of a small plot, probably represent the maximum of productivity. It is true that with a yield of 3,000 grains (=100 grammes weight) from one plant of wheat, and assuming sixteen plants to the square metre, one can reach a figure of 16,000 kilogrammes of wheat. But it is not to be expected that every plant will yield 3,000 grains. This is theoretically possible, but not probable.

European agricultural science, recognising as it does the impracticability of replanting cereals under present conditions of ownership, sees itself faced with a problem far different from those mentioned above. P. Wagner published, in his report on the work of his agricultural experimental station at Darmstadt for 1909, the results of experiments which had for their object the answering of the following question: "How many grains have to be sown in order to harvest 80 cwt. of rye and over from the hectare?" The multiplication of stalks was most marked where only 2-3 grammes were sown on the square metre. "As many as fifteen stalks were formed from one plant, and every stalk was exceedingly well developed." The number of grains in the ear where the planting was at wide intervals was 48, and thus one plant yielded at the utmost 720 grains of the weight of 24 grammes. The average yield in all the experiments was 800 grammes weight of grain to the square metre. "This works out to the enormous yield of 170 cwt. to one hectare. Such a yield is naturally out of the question in the open field." In the open field certainly, but not in the garden on well-tended and protected beds. Wagner comes to the conclusion that it is more advantageous to use small quantities of seed, say 70-90 kilogrammes, and not 140-160 to the hectare.

## IX.

What are the results which were obtained by the replanting of cereals? In his first work ("Die Vervielfachung und Sicherstellung der Ernteertrage," Berlin, 1909), Demtschinsky points out that "the harvests for winter rye obtained on the experimental fields of a number of farmers on fairly large areas mostly varied between Kg. 5,000-6,000 per hectare, and that in one case the yield of a small plot, when calculated to the hectare, gave a

harvest of Kg. 9,800 of winter rye. Experiments made in the neighbourhood of Moscow with the replanting of winter wheat produced Kg. 6,400 per hectare over an average of four years. Other experiments with rye produced a yield of 180 pood of rye from a half of a desiatin, and 150 pood from a quarter of a desiatin, *i.e.*, Kg. 5,300 and 8,800 from the hectare. In his "Ackerbeetkultur," which appeared two years later, Demtschinsky, in the chapter on "Practical Results," was already able to speak of the "enormous extension" of the application of this method (in some farms up to 1,000 hectares). Of course he was speaking principally of the hilling in the open field, which does indeed increase the yields, but not nearly to the same extent as the garden method of replanting, which is possible only in small plots. Demtschinsky found himself compelled to make concessions to European conditions of ownership, and to recommend only hilling. Of the examples adduced by him, the two which refer to replanting are particularly interesting. In the one case the plots with replanted rye produced 280 pood to the desiatin, whereas the highest yield from all other plots, treated with various kinds of manure but cultivated in the usual way, was only 130 pood. The nett proceeds amounted to 149.6 roubles to the desiatin for the replanted plot, and only 42.6 roubles for the best manured plot. The second case is that of the experiments made by the very progressive large land owner, Tscherkassov, in the Government of Kiev, who grew good Schlanstedt rye on manured and unmanured plots. On the occasion of the Seed Exhibition of the Kiev Agricultural Society in 1909, he gave a graphic representation of the results of his experiments by means of test tubes of the same diameter (half an inch) containing proportionate quantities of the various rye harvests. Tubes filled with corn from the other experimental plots reached a height of 2.8 to 13.8 inches, whereas that from the replanted plot would have filled a test tube of 336 inches. A special tube,  $4\frac{1}{2}$  inches diameter and 15 inches in height, had to be ordered so as to represent the yield of the replanted plot in proper proportions. Tscherkassov writes as follows, in his work "Experiments, Observations and Recollections of a Farmer," which he issued on the occasion of the exhibition: "The brilliant results of the rye harvest obtained by the replanting method both in quantity and in quality, and the simplicity of this method which enables it easily to be understood and used by every peasant, lead us to expect that this kind of cultivation will gain a footing more and



more in Russia as the extent of land owned by individuals diminishes with the increase of population." Himself a large proprietor, he rightly appreciates the importance of the Chinese method, which could not have been created except on small holdings, and he prophesies the downfall of large estates in the following words: "It is, of course, a thankless task to pry into the future, but one may say that this does not seem to have much good in store for the large estates. With the introduction of the method of replanting these must either vanish of themselves, or else completely alter their choice of the plants to be cultivated." It is interesting to note that Prof. Grandeau, in reply to a question from Kropotkin, wrote that he considered the replanting method for cereals perfectly feasible for Europe also. Paris market gardeners also saw nothing strange in this method.

## X.

I have said that the owner of, say, 10 hectares can by the method of bed cultivation (by this is to be understood the replanting, not the hilling alone, which is far from producing the same effect) obtain the same yield from a quarter of his estate as he can from the whole area by the ordinary "intensive" method. I do not mean by this that the proportion of the yields from both methods is that of one to four. Kropotkin maintains, on the basis of the experiments of Grandeau and Desprez, which led me to calculate a yield of about Kg. 11,500 of wheat from the hectare, that where at present three acres are required, one acre would be sufficient with planting at wide intervals. He probably had in his mind a yield of Kg. 3,500 from the hectare, which is obtainable according to the old methods of European intensive culture. Now in Palestine only Kg. 600 of wheat are harvested from the hectare. Here the difference between the present yield and that which is obtainable by the method of replanting will be far greater. Let us assume that according to this latter method Kg. 6,000 of wheat can be harvested from the hectare; this quantity corresponds to the present yield of 10 hectares. Where at present estates of 10-20 and even 25 hectares are assigned to Palestinian farmers from various quarters, with the introduction of the method of bed-cultivation 1-2½ hectares would suffice to obtain the same result. The only question is whether the size of the plot would not have to be determined by the lower limit in view of the labour capacity of the colonists. With practice and skill one man can replant 1,000 plants in an hour, or 600 when still only imperfect

at the work (these are the figures commonly assumed in the Isle of Jersey). If we allow a capacity of 6,000 plants per man per day, and 15,000 per family (wife and children must help), then the 150,000 cereal plants which go to the hectare could be replanted in ten days. This is the principal work, and can best be done by hand. There are, however, implements for this also, such as the planting stick used by Demtschinsky, and the replanting apparatus employed in the American tobacco plantations. The American has even replanting machines on his tobacco, tomato, and cabbage plantations. It would be quite worth while to learn the practical use of these implements and machines in order to be able to apply them to the bed cultivation of cereals (and also of other field-plants).

## XI.

The question for us is, then, shall we in the building up of Palestine introduce European conditions of ownership, and with them the "intensive" cultivation of the West, or the Chinese methods of culture and small holdings to correspond? To put the question is to answer it. Even to-day the 20-hectare estates are in many places a burden on the colonists, and are found by them to be quite unmanageable. In Galilee some colonists are said to have begged for a diminution of their estates, probably feeling that they will be able to cultivate small plots better and obtain from them a higher return. What it would mean for our colonisation if, say, only 2 hectares of land were assigned to each colonist, I will here indicate:—

1. The rent could quite comfortably be fixed at 5% of the purchase price of the soil, as, owing to the small size of the plot, it would be quite insignificant. The Jewish National Fund would be in a position to raise loans on its property, which it cannot do while the rent of the greater part of its possessions is only 2%.

2. The amount of live stock and implements, movable and immovable property required would be much smaller than it is for the colonists of the old type. The "Chinese" peasant does not require to keep a horse. Agricultural machines, as far as required, could be pulled by a tractor, which could be used by a whole number of smallholders.

3. Large settlements of 500 families could arise, in which each colonist could live on his own plot, and use for his work the time now spent in going to and fro. The communal burden would be correspondingly light.

4. Practical colonisation will be within reach of our means, which is more than we can say just now, especially after the general rise in the prices of all commodities. Our national institutions—the Jewish National Fund and the Banks—will do an enormous business. It will be possible to settle large masses in the country with some prospect of doing well.

5. The labour problem will be eliminated in the same way as in the system of small settlement on irrigated soil which I have recommended. The cultivation of the small plots will have to be done entirely by the owner himself and his dependants.

6. Palestine's capacity for absorbing new immigrants will, after the introduction of the intensive methods of small settlement with irrigation and of bed cultivation on dry soil, be far greater than has been imagined hitherto. There will no longer be any talk of crowding out the Arab inhabitants of the country by Jews. The country will have room enough for both peoples if the methods proposed by me are adopted.

The question discussed in this paper, as also that of the cultivation of irrigated soil, is not a purely technical one. It has bearings on our land policy, on the social system of the country, on our relations to our neighbours, and consequently on the nationality question, and last, but not least, on our finances.

## XII.

When will the introduction of bed cultivation for cereals be first taken in hand? Are we to await the slow and gradual progress of agriculture towards a higher intensivity? This would be a complete mistake. We must give our settlers the right methods to start with. We must train them to aim at the production of maximum harvests from the beginning. There is no bridge leading from Palestinian agriculture to Chinese bed cultivation. To recommend one is to condemn the other unreservedly.



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